Assessing the Impacts of Agricultural Management Practices on Crop Yields and Nitrate-Nitrogen Concentrations from Subsurface Drainage in Iowa

Ainis Lagzdins, Matthew Helmers, Carl Pederson, Linda Schott, Xiaobo Zhou, Aaron Daigh

Iowa State University




Introduction and Rationale

Nutrient reduction strategies are developed and implemented across the Midwest to reduce undesirable losses of nutrients in surface waters.

Agricultural management practices including tillage, nitrogen application timing and cover cropping systems are a promising way to reduce nitrate-nitrogen (NO_3-N) export from tile drained agricultural fields.

The specific objective of this study was to assess the impacts of above mentioned practices on crop yield and flow-weighted NO_3-N concentration under a conventional corn-soybean rotation.

Experimental Procedure

This research was conducted at the Gilmore City Research Facility located in Pocahontas County, Iowa, from 2011 to 2014. The treatments studied consist of 8 plots with both phases of a corn-soybean rotation, where 4 plots are in corn and 4 in soybean each year.

Nitrogen in the form of aqua-ammonia was applied only to corn at the application rate of 168 kg N ha^{-1}. Winter cereal rye was planted in October after the harvest of main crops and eliminated with herbicide treatment in April / May the next year depending on the field conditions.

Description of experimental plots:
CP – chisel-plow tillage;
NT – no-till;
FA – fall nitrogen application;
SP – spring nitrogen application;
rye – winter cereal rye cover crop;
168 - application rate (kg N ha^{-1});
C – corn;
S – soybean.

Fig. 1. Continuous subsurface drain flow measurements and composite water sampling.

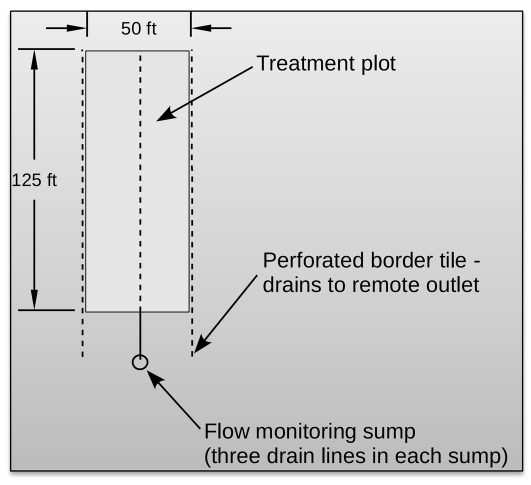

Fig. 2. Plot drainage design.

Results and Discussion

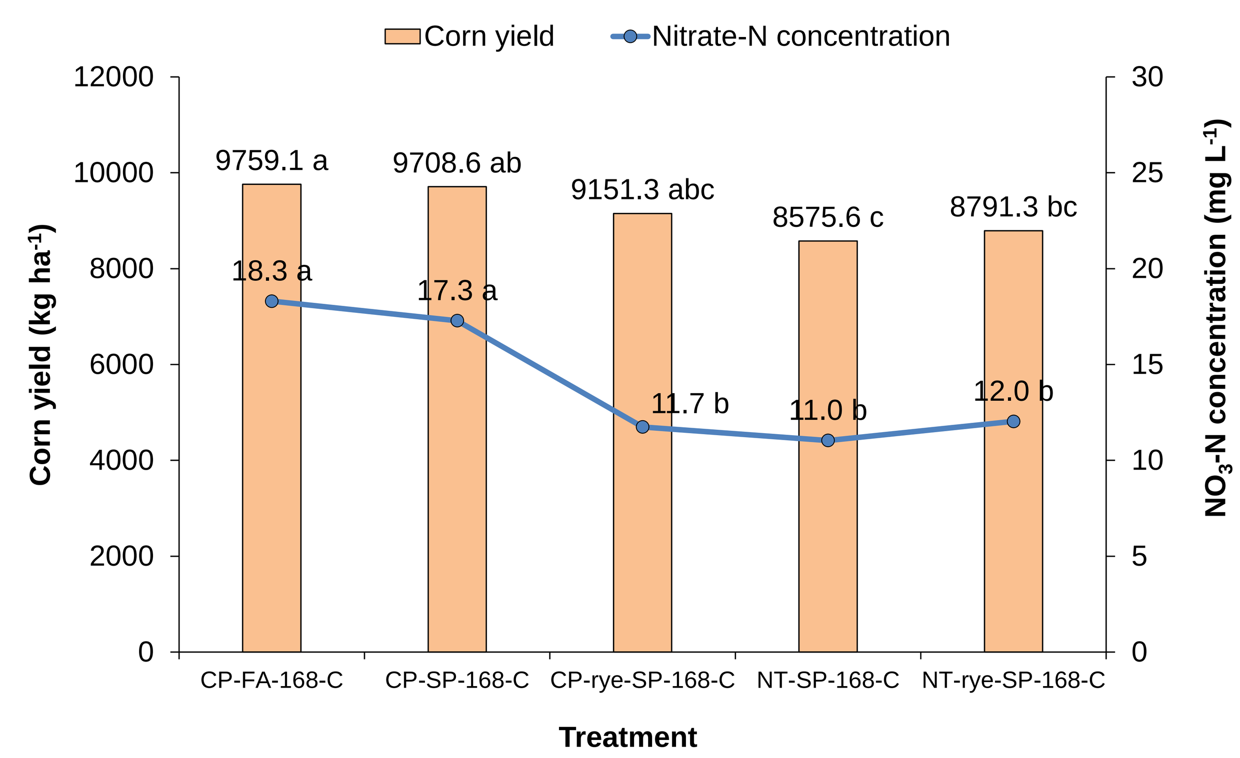

Fig. 3. Four-year average corn yield and flow-weighted NO_3-N concentration from five treatments (2011-2014). Means with a different letter are significantly different (p = 0.05).

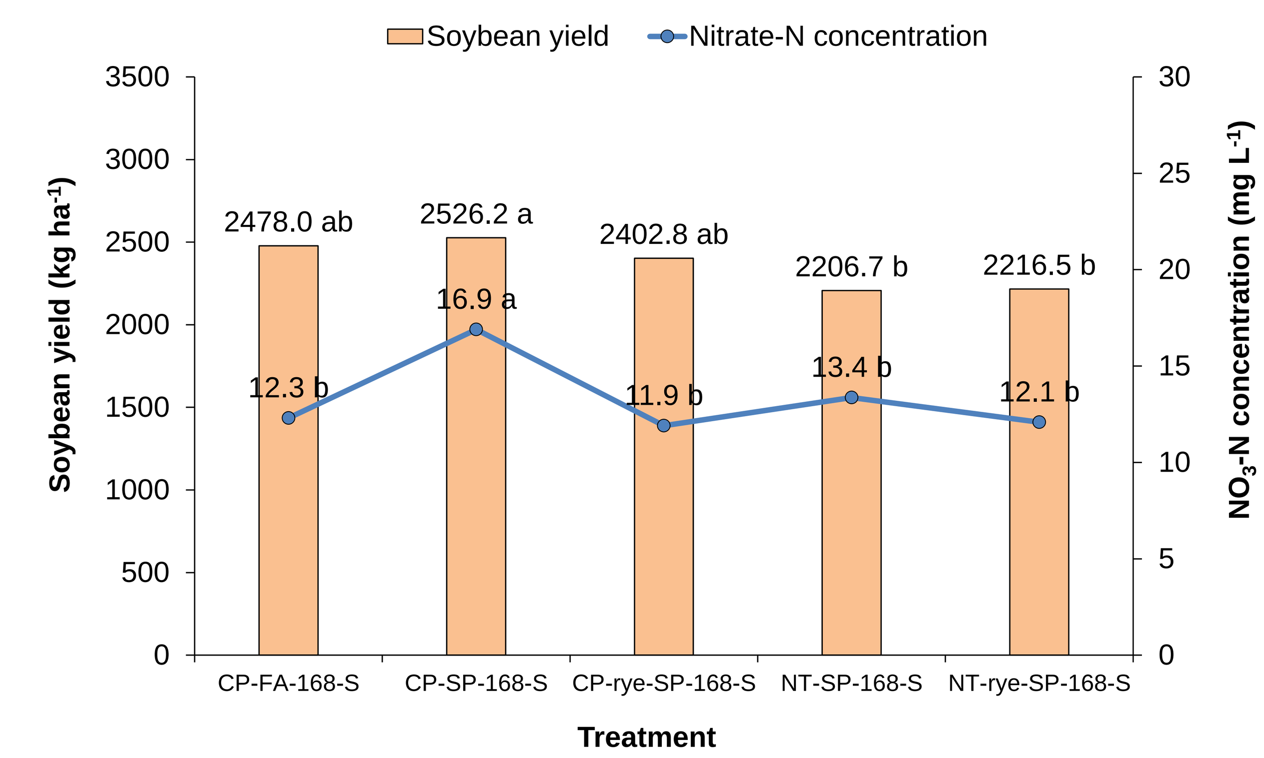

Fig. 4. Four-year average soybean yield and flow-weighted NO_3-N concentration from five treatments (2011-2014). Means with a different letter are significantly different (p = 0.05).

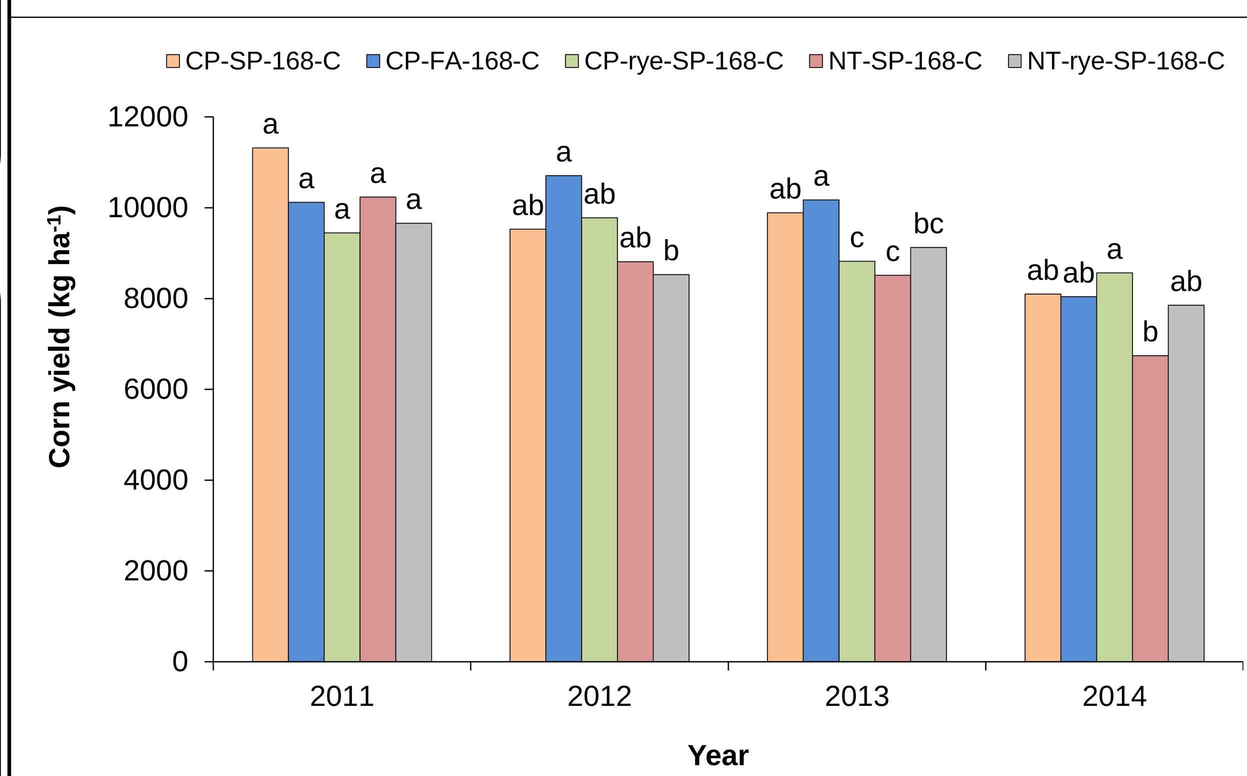

Fig. 5. Average annual corn yields from the treatments studied. Statistical difference (p = 0.05) was calculated for each year separately.

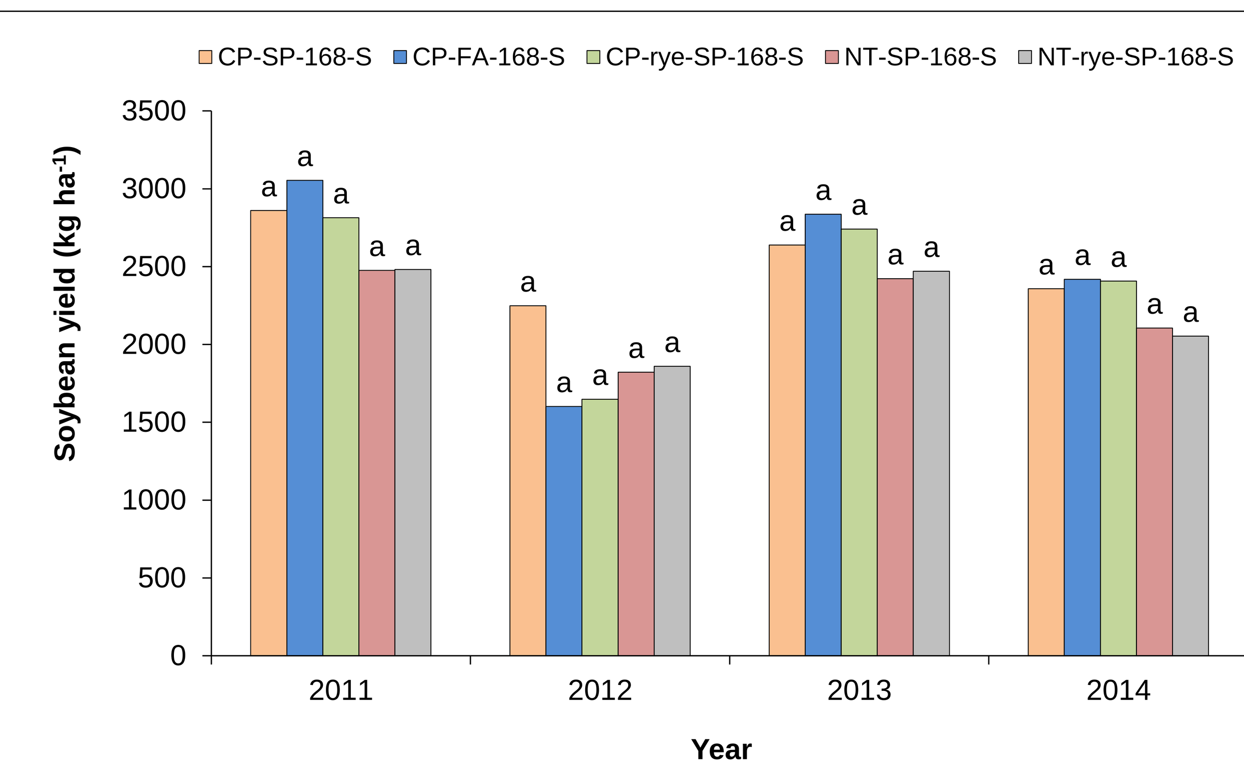

Fig. 6. Average annual soybean yields from the treatments studied. Statistical difference (p = 0.05) was calculated for each year separately.

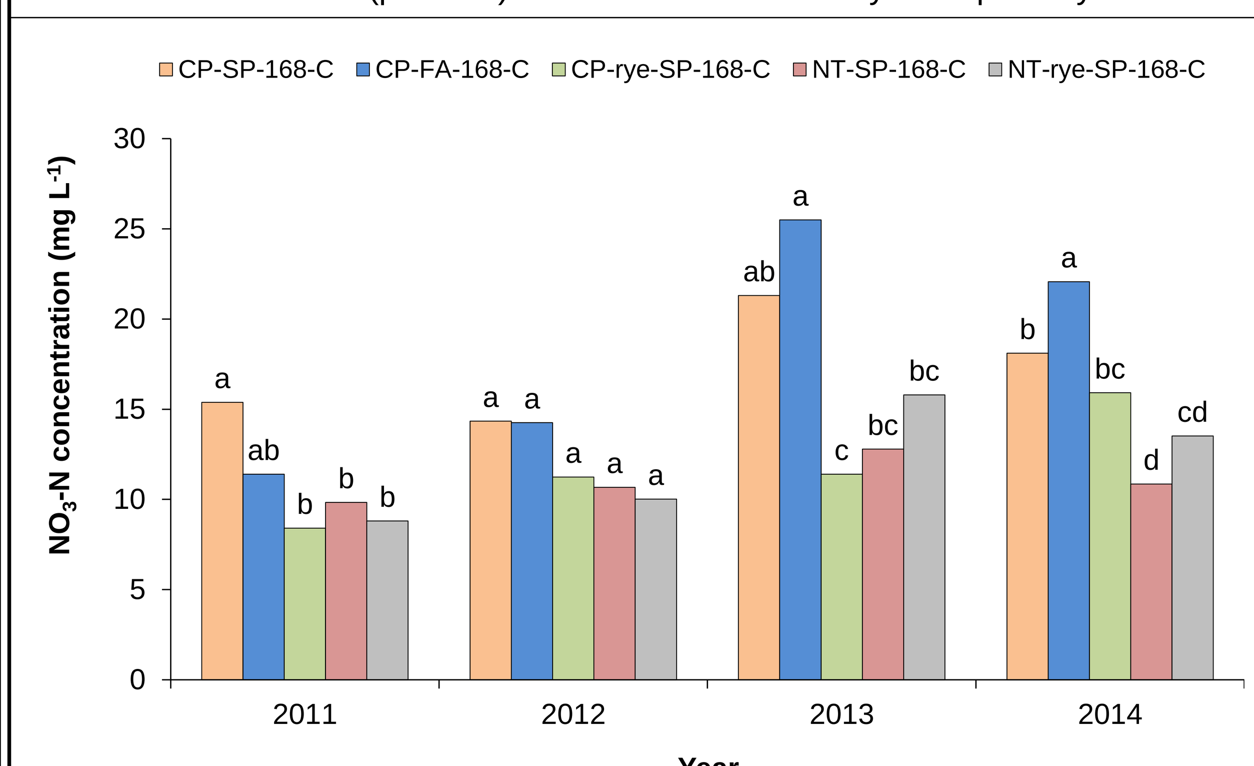

Fig. 7. Average annual flow-weighted NO_3-N concentrations from the five corn treatments. Statistical difference (p = 0.05) was calculated for each year separately.

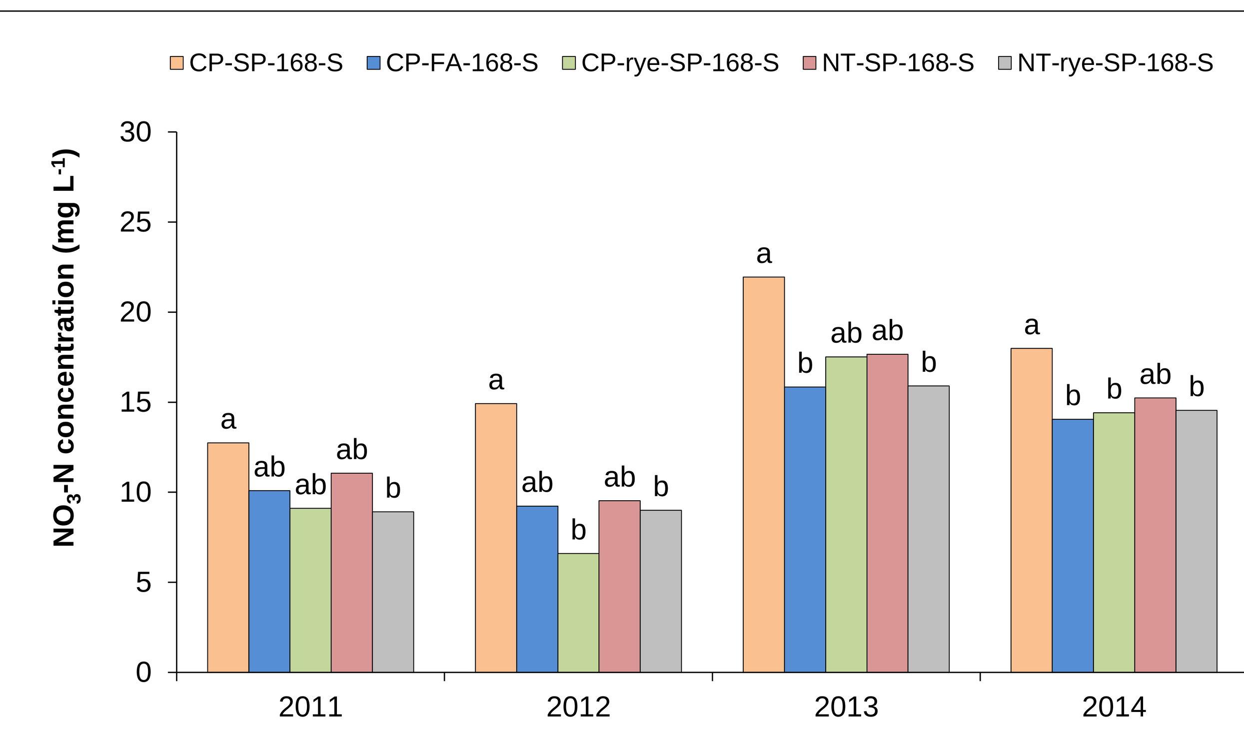

Fig. 8. Average annual flow-weighted NO_3-N concentrations from the five soybean treatments. Statistical difference (p = 0.05) was calculated for each year separately.

Conclusions

- Winter cereal rye cover crop and no-till practices showed the potential to reduce flow-weighted NO_3-N concentrations in subsurface drainage.
- Fertilizer application timing had little impact on NO_3-N concentrations for corn treatment, while soybean phase with fall applied nitrogen to the previous corn crop had lower NO_3-N concentrations.
- There are statistically significant differences in crop yields and NO_3-N concentrations between the treatments studied.

Recommendations

Winter cereal rye cover crop and no-till practices can be implemented in agricultural landscapes as part of a nutrient reduction strategy.

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